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INDOOR NAVIGATION SYSTEM WITH AUGMENTED REALITY USING EDDYSTONE BEACONS

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ABSTRACT

An Outdoor navigation system that depends on Global Positioning System (GPS) satellites are utilized by many individuals consistently. Lamentably, this sort of advances must be utilized to explore in open spaces and are not accessible indoor. To fill this need, we propose a simple and savvy framework to encourage precise indoor navigation system. By exploiting the Bluetooth low energy beacons and the sensors incorporated into a smartphone, a basic yet useful application can be created. This Indoor Navigation System uses fingerprinting, augmented reality (AR), and digital compass advances in an incorporated Android-based application. In particular, we utilized a fingerprinting strategy to decide client position, augmented reality to show continuous route, and a compass to determine the direction towards the destination.

KEYWORDS: Navigation, Beacons, Augmented Reality.

I. INTRODUCTION:

Individuals may visit new enclosed places like large buildings and need to reach certain locations inside those buildings. They may need a simple and friendly navigation tool to find locate their final destination. Nowadays the majority of individuals use mobile devices like smartphones and computers. Important for this particular research, modern mobile phones are equipped with powerful chips, expandable memory, cameras that capture video and still images, and advanced sensors that offers the capability of determining the position of the device using GPS, accelerometer, compass and gyroscope [1].

Adding such powerful tools and functions to smart phones allows them to perform high performance functionalities such as augmented reality technology [2]. Augmented Reality (AR) is the technology that superimposes the computer made objects over a genuine world that is captured in real-time by the camera so that they seem to be like one environment [3]. The computer generated objects may be 2D or 3D design, words, audio, video which augment and integrate with the physical world to show useful information to an individual and help him to connect to the application in a fairly easy and comfortable way. Smart phones users may use their phones for navigation to specific places. Most navigation software use the Positioning System (GPS) to determine both the user and desired destination positions. These app types are perfect to guide an individual outdoors by disclosing the guidelines and distance between your customer and their desired destination [4]. In enclosed places such as structures, airports, and market segments, however, GPS satellite signs become poor or non-existent; therefore, GPS navigation is not well suited for indoor positioning and navigation [5]. There are lots of indoor navigation techniques you can use rather than GPS in augmented reality systems such as ultra-sound, optical marker-based, optical markerless, magnetic, inertial, super wide-band (UWB), hybrid, accelerometer, productive RFID, unaggressive RFID, and Wi-Fi fingerprinting [7, 8,6]. The feasibility of using a specific approach to locate the user indoors depends on several factors such as accuracy, infrastructure, cost, complexity of implementation, delay time, updates rate, operating range, portability, and tracked target mobility [9].

Beacons are a low-cost piece of hardware, small enough to attach to a wall or countertop- that utilize battery, friendly Bluetooth connections to transmit messages or prompts directly to a smartphone or tablet. They are poised to transform how retailers, event organizers, transit systems, enterprises, and educational institutions communicate with people indoors. Consumers might even want to deploy them as part of home automation systems.

II. APPLICATIONS:

Indoor navigation system has become a momentous field in several areas such as:

A. Airports:

In the complex structures like that of an airport, it is very difficult to track. Different terminals, the fastest way to the right check-in counter, the right gate, our application can help in the preparation of the fastest and the most optimal route inside an airport.

B. HealthCare:

Hospitals and health care centres are eager to indulge technology to offer their patients the best possible service. In fact, happy patients contribute to the good reputation of a hospital. For example, a patient application helps navigating in the building and facilitates accessing services. Wi-Fi, beacons and could optimize the processes. Mobile medical equipment can be found quicker, staff is being relieved, hygiene rules controlled, itineraries analysed, appointments coordinated and costs reduced.

C. Trade Fairs:

With our application, we can create value added services for exhibitors, organizers and visitors. All pertinent knowledge about the fair, the exhibitors, products, services and the event program can be easily retrieved by visitors. Personalized knowledge makes the fair tour easier and the exhibitors will also profit from this. A large vary of support choices for your exhibitors allows you, because the event organizer, to simply recoup the prices of your individual trade app.

D. Parking areas:

An indoor parking garage may be located in a multi-storied building. Once a person leaves a car, one does not always remember the exact location or the parking lot number. Indoor Navigation system can improve driver experience by allowing them to put a pin on the car's accurate position on the map and let the system remember it. Once a person returns to the garage, he / she will not have to spend extra time looking for the car afterwards, but just open the mobile app's map and build a route to it.

III. TECHNOLOGY USED FOR INDOOR NAVIGATION:

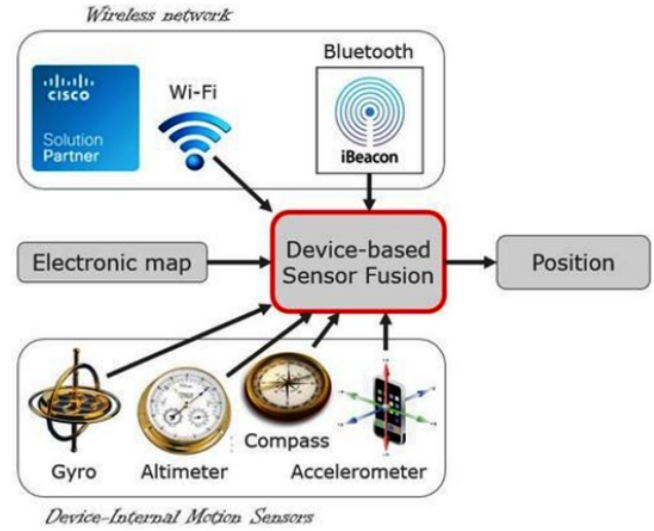

Fig 1: Different Technologies used for indoor navigation

A. Wi-Fi:

Wi-Fi is a radio technology that permits users to connect to the network through

devices known as Access points(AP). It performs mainly over the two 2.4 GHz and 5 GHz "Industrial Scientific and Medical" (ISM) Frequency band and has been standardized by the Institute of Electrical and Electronics Engineers (IEEE) as 802.11.Through the entire years, numerous requirements of the Wi-Fi process have been developed, providing network throughput advancements over their successors. The first official standard of the process was the 802.11b accompanied by 802.11g, 802.11n and 802.11ac. Both "b" and "g" variants function on the two 2.4 GHz ISM group and are widely used. They use 20 MHz of bandwidth to transfer over 14 overlapping channels 22 MHz long, three of which (1, 6 and 11) do not overlap and will be the mostly used.

B. Bluetooth:

Bluetooth is a radio communication technology which allows gadgets to connect over small ranges and, as Wi-Fi, works on the two 2.4 GHz ISM frequency band. Despite working on a wide open band, the Bluetooth technology is controlled by the "Bluetooth Special Interest Group" (SIG) and was standardized by IEEE as IEEE 802.15.1, though it no longer maintains the standard. Common types of Bluetooth devices are mobile headphones, game controllers, cellular keyboard and mouse. Bluetooth uses 79 channels to transfer data, starting with the first channel at a rate of recurrence of 2402 MHz and carrying on up to the previous one at a regularity of 2480 MHz in 1 MHz increments. To avoid disturbance from other RF signals, a method known as rate of frequency hopping, where data is sent over one of the available channels for a small time period and resent over another channel in case there is interference, is used.

In order to transfer data, Bluetooth devices must first establish a connection. A single device is capable of joining up to 7 devices and interacting with every one of them simultaneously. That is done by using a interconnection model known as "master-slave", where the device that initiates the bond can take the role of master over the other devices. Every time a master and a slave set up a connection, a relationship is created, permitting them to transfer and acquire data. Designed as a low-power technology, Bluetooth is intended to operate on battery devices over relatively brief distances. Just like Wi-Fi, the utmost distance over which a Bluetooth device can establish a connection is determined by its output electric power, and also other factors such as signal reflection induced by obstacles.

IV. RELATED WORK:

A. Beacons:

Bluetooth beacons are hardware transmitters - a class of Bluetooth low energy (BLE) devices that broadcast their identifier to local lightweight gadgets. The technology permits smartphones, tablets and other devices to execute actions when near a beacon. Bluetooth beacons use Bluetooth low energy proximity sensing to transmit a universally unique identifier found by the compatible app or operating-system. The identifier and many bytes sent with it could be used to look for the device's physical location, track customers, or trigger a location-based action on these devices like a check-in on social media or a push notification. One application can be an indoor positioning system, which helps smartphones determine their approximate location or context. By using a Bluetooth beacon, a smartphone's software can approximately find its relative location to a Bluetooth Beacon in a store. Offline shops use the beacons for mobile commerce, offering clients special deals through mobile marketing, and can permit mobile payments through a point of sale systems. Bluetooth beacons differ from various other location-based technologies as the broadcasting device (beacon) is merely a 1-way transmitter to the acquiring smartphone or acquiring device, and necessitates a particular app installed on these devices to connect to the beacons. This means that only the installed software (not the Bluetooth beacon transmitter) can track users, potentially against their will, as they passively walk around the transmitters.

B. Augmented Reality:

Several indoor satnav systems using augmented reality have been suggested over the last couple of years. These systems start using a variety of positioning techniques like a marker-based, vision-based, markerless, RFID, and activity-based instruction. The marker-based strategy requires placing predefined markers inside the building environment and generating and displaying the signage and orientations depending on those markers [14]. There are many projects that may be used to build up the marker-based augmented simple fact on Android platforms including the AndAR job [13]. Vision-based technique requires looking at the captured images by the camera with a pre-defined group of pictures stored in a database and seeking the place by complementing [11]. Activity-based instructions technique chooses information details in the building and shows info with regards to the activities of an individual [12]. Some experts suggested hybrid navigation system that uses RFID and markerless augmented reality .

C. Indoor Navigation Using Beacons:

Indoor navigation applications help to locate and guide visitors to navigate using their mobile devices. Bluetooth Low Energy advertising signals from beacons are the base of our indoor navigation system. Beacons are located at several location inside the building. Placement of Beacon device is a very important step to ensure that the desired accuracy is achieved in navigation. They constantly broadcast advertising signals with an unique identifiers to nearby mobile devices. Mobile application on mobile phone will locate their position using beacon signal for navigation. Mobile devices can approximately determine their distance to the beacon via quality of signal strength. Beacons transmits advertising signal to smart phones using Bluetooth Low Energy (BLE). This advertising signal offers location information to mobile device. Mobile application can interpret the signals, and trigger a task that is specified in the application. Approximately based on strength of BLE advertising signal received by mobile device distance is predicted. A routing algorithm computes the perfect path from user location to destination [17][16]. The API gives approximate distance to a beacon in meters. This way, it is possible to determine user's location consistently and navigate them through the building. Mobile application not only helps users to know their position but also help them to find route to their desired destination inside the building. As a result indoor navigation system can be used to provide better experience to users.

V. SYSTEM ARCHITECTURE:

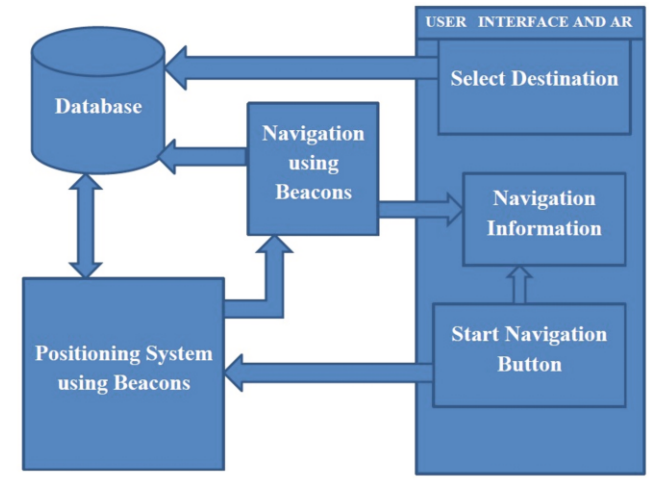

Fig 2: System Architecture for indoor navigation system

The application will help to pair the device with Bluetooth low energy beacon. After pairing the beacon it will detect the location of the person. The person will be asked to enter the destination. As destination is entered, it will be checked in the database, and then the desired path for the navigation is displayed. The navigation is displayed by using augmented reality in the frontend.

VI. IMPLEMENTATION:

The system works as follows: first, few beacons are situated around an area. Then, the application scans for them and gathers their RSSI psychic readings. These readings are, in turn, used to compute the distance between customer and each beacon. Seeing that no information being showed by the beacons signifies their position relative to the receiver, the software makes use of both gyroscope and compass included in the mobile device to know in which direction the person is moving.

A. Hardware:

A smartphone using Android version 5.0(Lollipop) can be used to host the application. It is important that BLE capabilities are only available on Android devices using version 4.3 (Jelly Bean) or newer.

Few BLE Beacons are used to provide the reference signals. In order to achieve optimal performance, beacons must be configured using the configuration application provided by the beacon manufacturer.

B. Application:

The installed application captures the signals and uses proximity technology and calculates the distance from the mobile phone to a beacon device which enables to show one's real time position on the map.

C. Scanning:

The BLE adapter scans for local BLE devices and the results of every scans are passed to an Eddystone filter. This filtration is employed to discover if the beacon uses the Eddystone protocol and, if it does, it validates its frames and states the information contained in them. These filters and other utilities necessary for reading Eddystone frames are provided by Google at their GitHub repository [15]. The application will seek out all Eddystone support frames that could be included in the BLE bundle. Both Telemetry and LINK frames are optional and can be omitted, however, the UID frame must be present at all times. If no UID frame is located, the filter will disregard the device. An additional display screen where users are able to see all beacons in range and the contents of their structures is available from the menu bar at the top of the display screen.

D. Navigation:

Just after checking the desired destination in the database, the application will begin calculate the distance to each of the configured beacons. These calculations will be later used for the navigation using Augmented Reality.

VII. CONCLUSION AND FUTURE SCOPE:

In this paper, we have presented, An Indoor Navigation System Using Augmented Reality, which utilizes Bluetooth Low Energy (BLE) technique as a positioning system and displays the information to the user using augmented reality. Our system determines the direction toward the destination on the fly using the smart compass of the mobile device. We will work to improve the performance of the system on all the intrinsic parameters like range, accuracy, accessibility and security.

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